Regenerative Design for Future Cities

How synergistic and environmental conscious design help create value to our places

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A Thesis
Presented to
The Faculty of the Department of Architecture
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In Partial Fulfillment
of the Requirements for the Degree of
Master of Science of Advanced Architectural Design

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by
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ABSTRACT

Architectural design is closely tied to our urban systems and the built environment. With increasingly densified spaces and overwhelming construction projects, how will our city sustain and revitalize itself under this social and demographic change? Regenerative design by definition is a restoring and renewing process that integrates the social, economic and environmental aspects into the urban system in order to promote a more resilient living environment aligning with the social needs of all[1]. This process is established upon the cultural value of each specific place, the environmental conditions, and the socio-economic aspects.

This project will examine the two directions *Regeneration Towards Urban Synergy* and *Regeneration Towards Ecological Resilience* exemplified by design works throughout the TI of Architecture and Urbanism at Cornell University. The design works contain studio projects and feasibility analysis during seminars that embrace the multi-perspective realm of regenerative design.

1. Lyle, John Tillman. Regenerative Design for Sustainable Development. New York: Wiley, 1994. Print.

ABSTRACT

This project argues that regenerative design, both at the architectural and urban scales, is key to create values within our cities. This process celebrates the idea to regenerate, rather than exhaust our energy and resources, which helps re-aligns our social life with the natural environment as a integrated system[2]. At the same time, the regenerative design celebrates the dynamic urban life for our future cities towards a resilient system.

2. Berkes, Fikret., Johan. Colding, and Carl. Folke, eds. Navigating Social-Ecological Systems: Building Resilience for Complexity and Change. Cambridge, U.K.: Cambridge University Press, 2003. Print.

BIOGRAPHICAL SKETCH

Jiayi Yi is an architectural designer from Shanghai who currently studies M.S.AAD at Cornell University. In 2018, she graduated with a B.Arch degree from the University of Notre Dame with a minor in sustainability and a concentration in business. After graduation, she pursued her interest in architectural design at Cornell University to investigate architecture in the context of city, environment, and technology.

Jiayi believes that good design is resilient, experience-driven and integrated with the environment and people. Innovative design solutions have the power to promote connectivity and a sense of place within the city. With TI of Architecture and Urbanism, she explores the regenerative development within the cities and its influence on the everyday life of people.

DEDICATION

To my parents Rong Yi and Wan Wang, to myself,

and to all architectural students who fight for their dreams.

ACKNOWLEDGMENTS

I would like to express my deepest appreciation to all professors who provided me with the knowledge and support to complete this project. Special gratitude gives to my final semester studio professor Jenny Sabin, whose constant encouragement and inspiring ideas helped me to achieve great progress and success in my studio project and personal journey of architecture. Furthermore, I would also love to acknowledge with much appreciation my seminar Prof. Henry Richardson whose crucial role helps me explore the realm of real estate and virtual reality extending my scope of architectural practice. Special thanks go to my teammates, classmates, and friends who supported me both academically and mentally with hardships and joy in life. Many thanks to Graduate Programs Coordinator Cindy Bowman who has coordinated all events for the success of this program.

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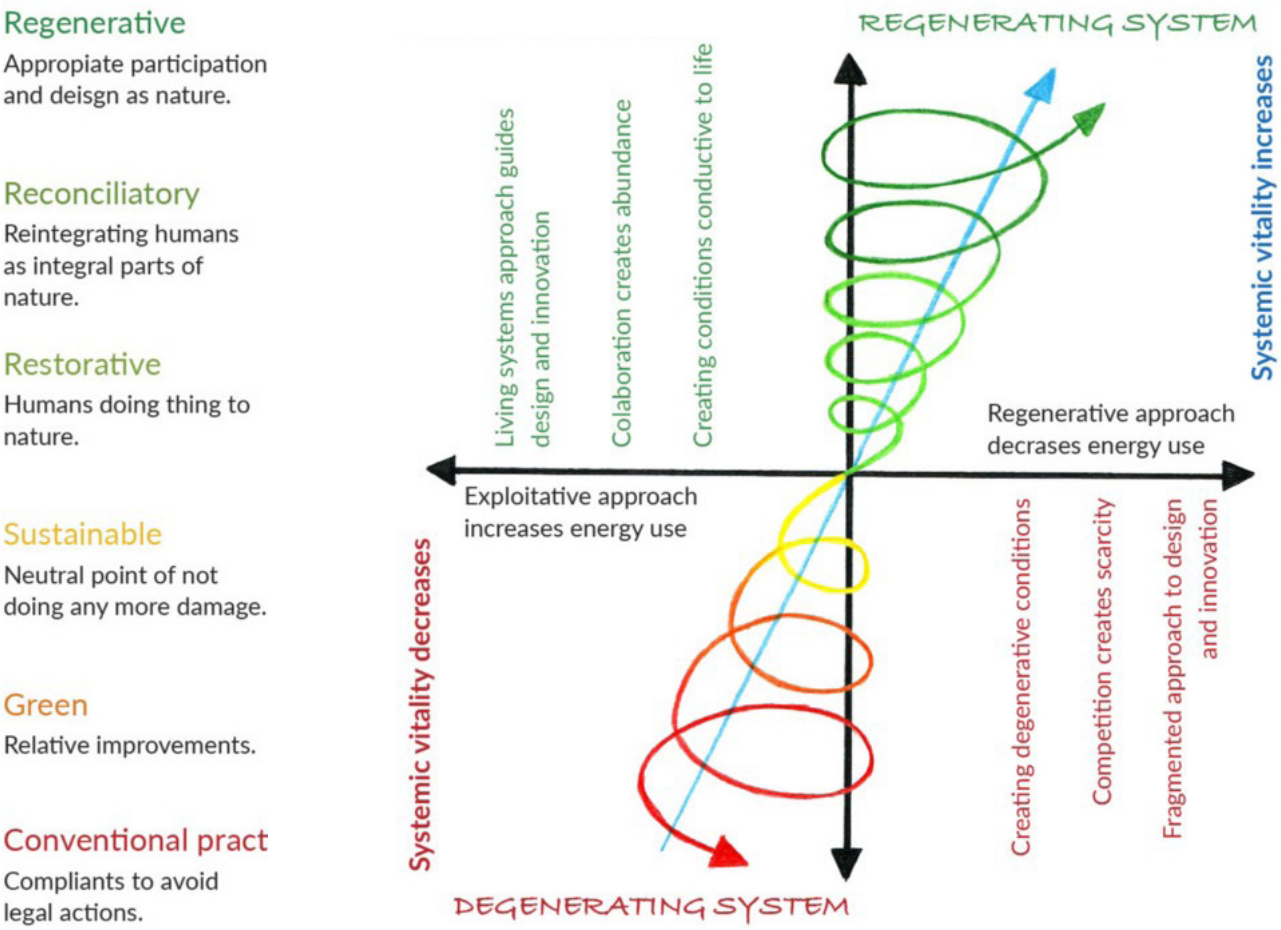

Figure 1.1 shows the regenerative system towards systemic vitality

Our cities developed rapidly under constant construction and a growing urban population. Under this social and demographic change, urban regeneration has emerged to strengthen the vibrancy and enhance the human experience within the cities. According to United Nations, 68% of the world population will be living in urban areas by 2050.[3] When our urban environment in the future becomes crowded with expansions, what changes shall we make to renew and sustain our cities and keep it breathing and alive. Figure 1.1 shows the regenerative approach to promote the vitality within our urban system.

3. Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2006 Revision and World Urbanization Prospects: the 2007 Revision, http://esa.un.org/unup

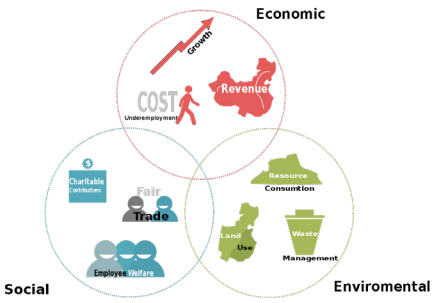

Figure 1.2 shows the social, economic and environmental considerations of regenerative design

It becomes crucial for regenerative design to be grounded on the culture, humanity, and ecology of our future city development. Urban regeneration is not just the improvement on urban infrastructure, but more importantly an integrated approach towards the sustainability and regeneration of our environmental conditions, cultural values, and social environment. Regenerative development encourages the planning and growth within the cities towards social, economic and ecological resiliency, and lines up human activities with the evolution of our built environment[4].

The vision of urban regeneration of our future cities is aligned with the unique cultural condition and value of people. While we design to provide human scale urban space and housing for people and encourage abundant human activities, different scenarios vary in different cities. For example, cities in China experience very different political and urban issues with that in UAE, and the cultural legacy of the city shall be fully respected while embracing the most advanced building technology. Urban regeneration is essential to address urban decay and live up the dynamic urban organism, and this process is key to shape our future cities to confront the rich complexities within our urban system[5]. In this critical text, I will address the social, cultural and environmental aspects of regenerative design and how its capacity will influence our cities in the future.

4. Mang, Pamela, and Ben Haggard. Regenerative Development and Design: a Framework for Evolving Sustainability. Hoboken, New Jersey: Wiley, 2016. Web.
5. Hemenway, Toby. The Permaculture City: Regenerative Design for Urban, Suburban, and Town Resilience. White River Junction, Vermont: Chelsea Green Publishing, 2015. Print.

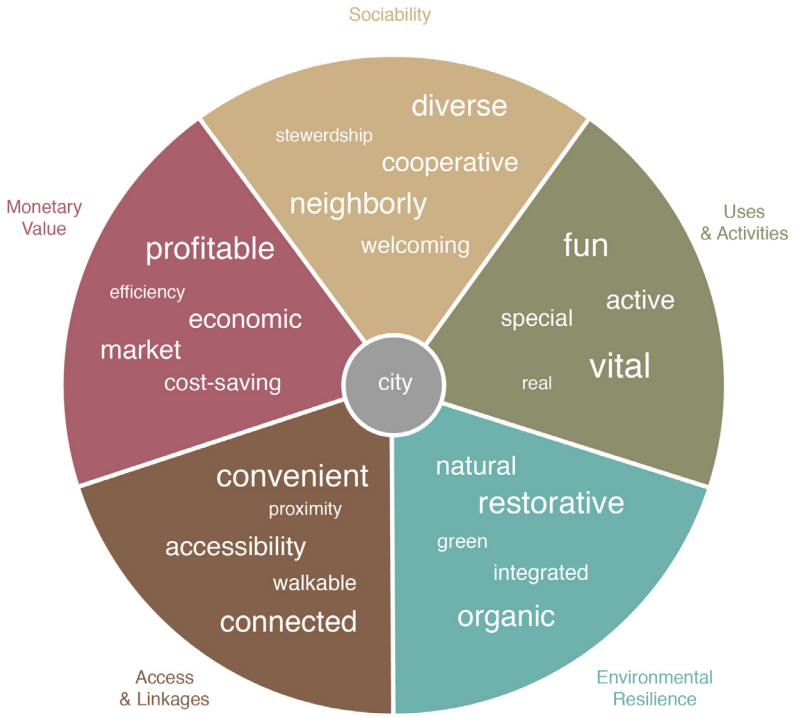

Figure 2.1 shows the conceptual framework to evaluate regenerative design

When thinking of what elements contribute to a good city, we evaluate on how regenerative design affects the quality of our built environment through five main aspects: sociability, uses and activities, environmental resilience, access and linkages, and monetary values[6].

In terms of *Sociability*, we look into how regenerative design helps to increase the social capital of the place by encouraging diversity of street life, cooperativity among different user groups and a sense of neighborhood. Important characteristics include diverse, stewardship, cooperative, neighborly and welcoming places.

In the category of *Uses and Activities*, we evaluate the space on its vitality and usage adaptability, including how the place generates property value and nurtures a

6. Thomas, D. (2016). Placemaking: An Urban Design Methodology. New York: Routledge, Taylor & Francis Group.

dynamic atmosphere for the public. Key characteristics include active, fun, vital, special and real places.

In the realm of *Environmental Resilience*, we start to integrate the ecological conditions into the urban systems. We consider the restorative values of place to create comfort and a dynamic place for people, and sustainable values of renewable energy into the building systems. Key aspects include natural, restorative, green, integrated and organic.

In the category *Access and Linkages*, we further examine how regenerative design creates a value of place in the context of connection to other parts of the city through transportation convenience and pedestrian accessibility. Important standards include proximate, connected, walkable, convenient and accessible places.

In *Monetary Values*, we look into how regenerative design in cities brings profitable values and economic flows to the place. The more quantitative aspects of monetary values help target upon the specific outcome regenerative design could bring to the place. Important elements include profitable, efficient, economic, market and sustainable.

Regenerative design is crucial for our future cities. Our cities shall not be established upon consumption, because one day the cities will start running out of the resources on the planet. Therefore, the concept to restore the resources and revitalize the urban environment will be key to shape smart cities. Regenerative development is a process to respect the existing urban fabric and local culture and create a design that celebrates the connectivity and walkability among the neighborhood[7]. Rather than monotonous high-rise development, it is essential that we design the uniqueness of that place to truly revitalize the life of local people.

In our modern society, we are facing different urban problems, including traffic congestion, lack of public space, air pollution, isolation among people and destruction of traditional houses. Facing all these problems, we could not repeat the past constructions unconscious of our urban environment, and instead, we shall search out ways to relieve these social and environmental problems. Part of the key concept within the regenerative strategy is to consider the cities as an integrated system that incorporates the needs of human beings while speaking to the restorative qualities of our nature. The design that includes landscape as part of the urban strategy will encourage activities and vitality among the people and greatly relieve the problems of lack of public space and pollution.

7. Berkes, Fikret., Johan. Colding, and Carl. Folke, eds. Navigating Social-Ecological Systems: Building Resilience for Complexity and Change. Cambridge, U.K.: Cambridge University Press, 2003. Print.

From the economic point of view, the regenerative design that embraces mixed-use development will not only create opportunities for local business but also encourage various activities among people and convenience for the daily life[8]. The understanding of our community as a connective and vibrant whole will help the cities create more social and economic capital in the future through regenerative design.

In this chapter, we will look at three design projects and understand how they each contribute to a more dynamic neighborhood and generates value over time.

8. Lyle, John Tillman. Regenerative Design for Sustainable Development. New York: Wiley, 1994. Print.

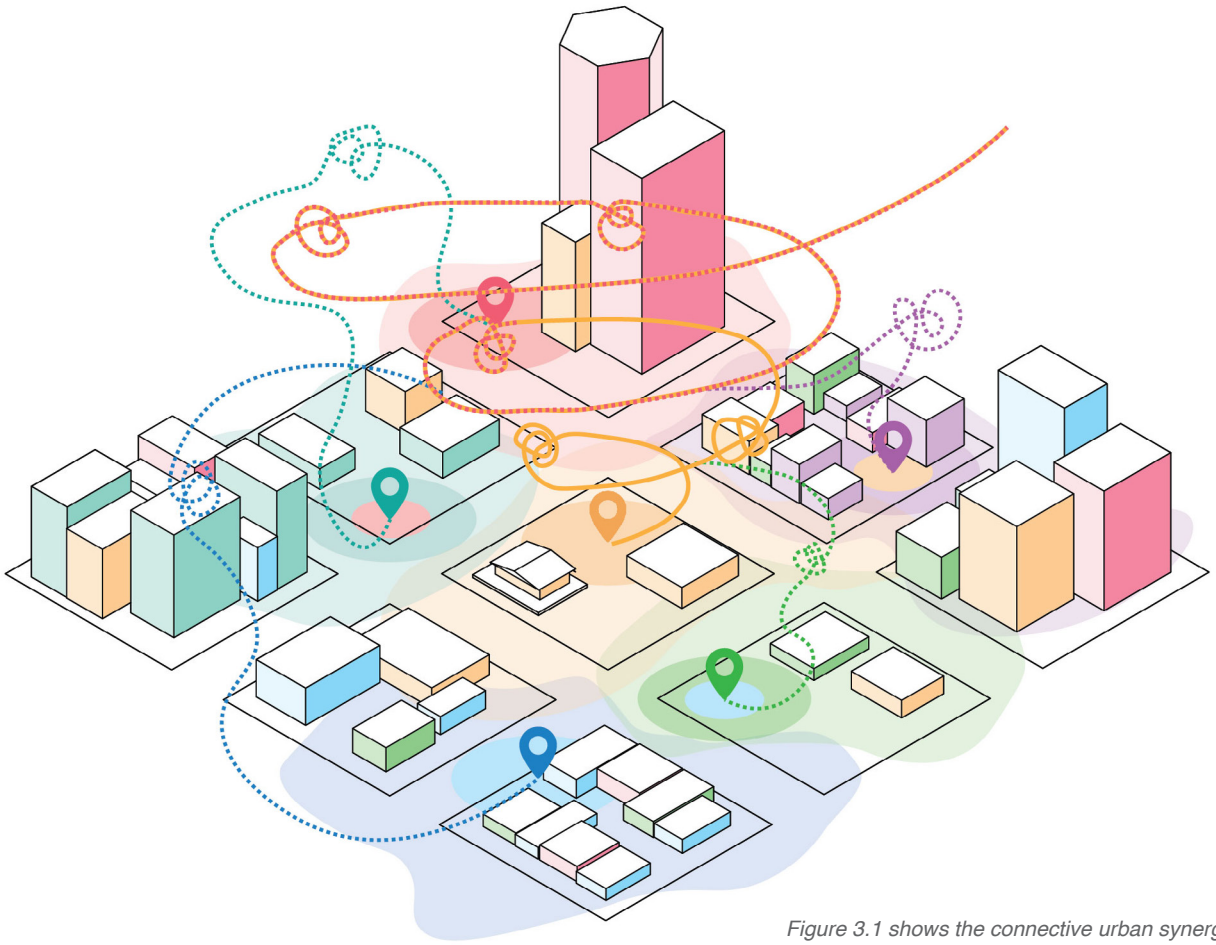

Figure 3.1 shows the connective urban synergy

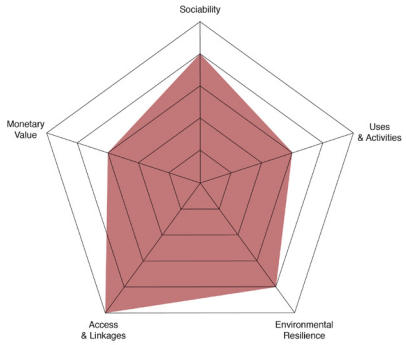

Figure 3.2 conceptual framework evaluation
Fall 2018
Prof. Leslie Lok
ARCH Studio: Sectional CIty

The city Chongqing is featured with unique mountainous topography. Figure 3.3 maps out the hierarchy of the streets and the “residue slots” that appear along the changing topography. This mixed-use housing project aims at forming a linkage with the existing city fabric and revitalizing these slots as active spaces for the everyday life of local people.

This project evaluates the unique urban life of Chongqing, where people would love to spend their leisure time drinking tea, playing Mahjong and shopping[9]. In order to restore the Chongqing-esque urban life and respect the natural topography, the design creates a multi-ground condition for the public with connected underground levels and pedestrian realms, which at the same time serves the vital social life for residential units above.

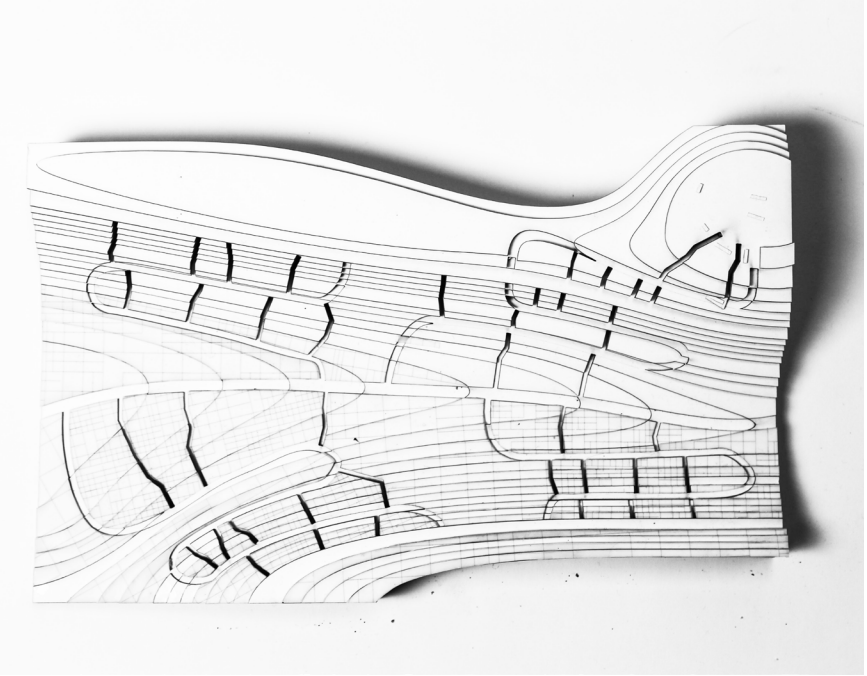

Figure 3.3 shows the he physical model mapping slots across site

9. “Chongqing” ke ti zu. Chongqing. Di 1 ban. Beijing: Dang dai Zhongguo chu ban she, 2008. Print.

Additionally, within this urban fabric, Figure 3.4 shows a hierarchy of green courtyard spaces. The orientation of the upper-level housing facing the northwest caters to the dominant wind direction in summer, which provides ventilation throughout the site. The idea to use natural energy within the building system helps create a breathable ground for this regenerative design.

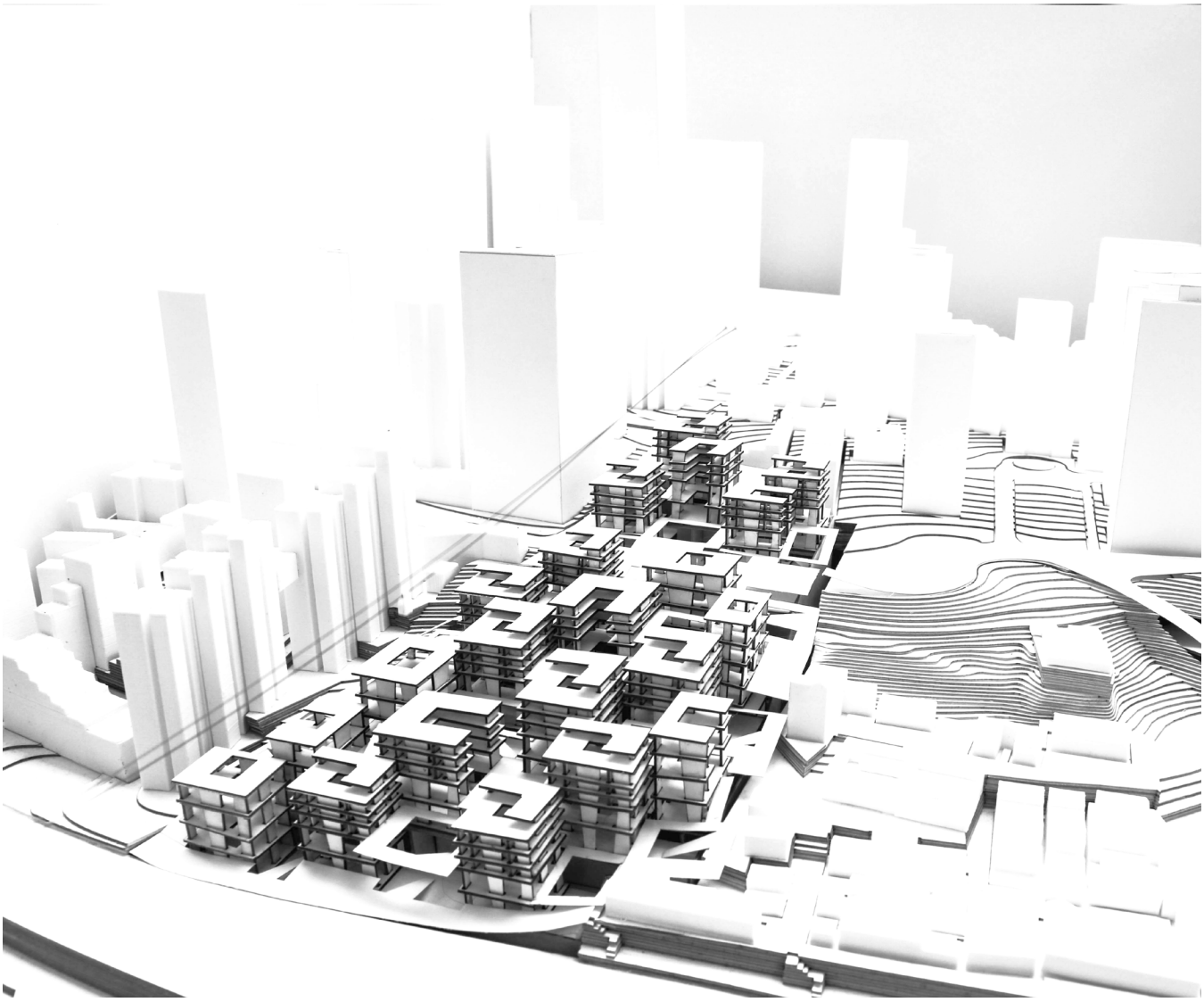

Figure 3.4 shows the mixed-use public housing with a hierchy of courtyards

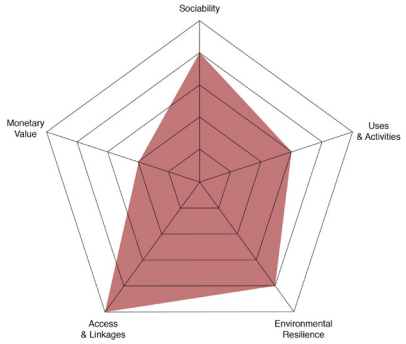

Figure 3.5 conceptual framework evaluation
Summer 2018
Prof. David Moon, Nahyun Hwang
ARCH Studio: Architecture + Urbanism

The Central Business District along 48-65th Street of Park Avenue has been featured mostly with Class A office buildings. While crowded with elites during the day, this area loses its dynamics during the nighttime when people get off their work and go home. Therefore, this project is proposing a regenerative urban strategy that promotes abundant activities and social life all day long while creating an urban park that connects the current isolated public spaces.

The current spatial condition along Park Avenue with four vehicle lanes on either direction is undesirable for the pedestrians. The wide median in the center of around 1.2 meters' wide serves solely as the vehicle buffer, which used to be a public park for people[10]. Therefore, the idea emerges to take use of the air space above the median that creates public green spaces within the most needed area in Manhattan.

10. Andy. "Andy." Forgotten New York, forgotten-ny.com/2017/10/park-avenues-hidden-history/.

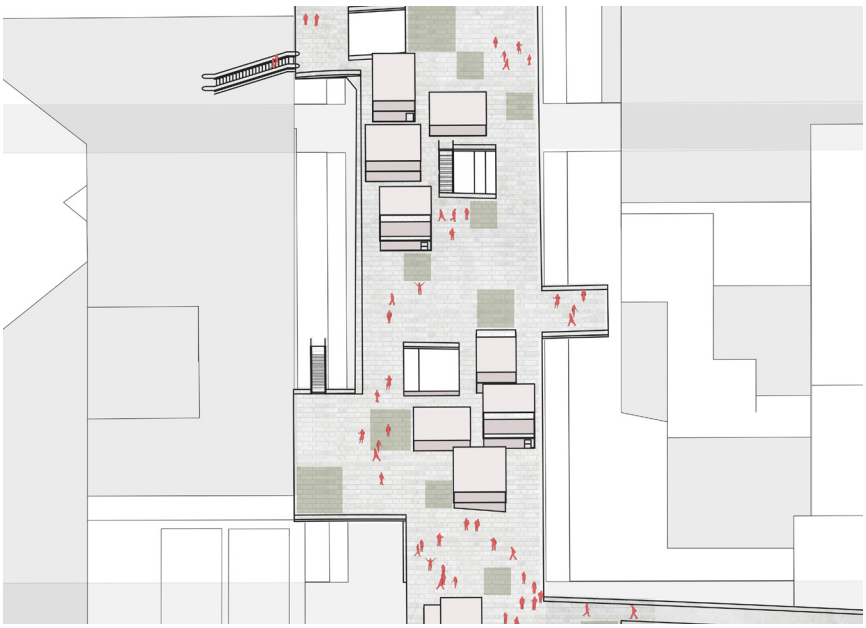

Figure 3.6 shows the proposal of urban park within the city

Additionally, the proposal as shown in Figure 3.6 and Figure 3.7 includes a series of public housing alongside the park. People are the most central part of a dynamic neighborhood. With the mixed-use zoning being promoted, space will be regenerated to embrace all various human activities. The integrated system of social life and nature helps the urban environment to become more resilient and equitable.

Figure 3.7 shows the proposal of mixed-use synergy within the city

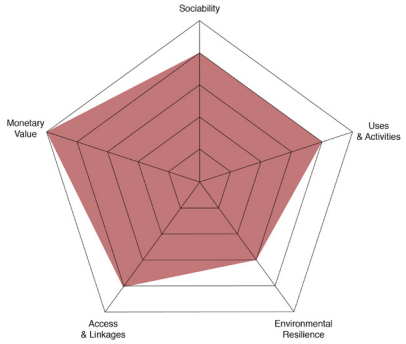

Figure 3.8 conceptual framework evaluation
Fall 2018
Prof. Henry Richardson
Seminar: Design of Real Estate

Figure 3.9 shows zoning analysis

The current site of Municipal Lot in Downtown Flushing is an open parking space. The feasibility study of this Flushing project is aiming at creating a dynamic neighborhood that will connect to the existing city fabric and support the everyday life of local people. The study starts with a series of zoning and vicinity analysis. Figure 3.9 shows the current zoning of Municipal lot at orange Commercial Zone injunction with the driveway on its north from Manhattan and on its south from Queens. Figure 3.10 shows the surrounding programs of parking, hotels and green space that currently exist in the neighborhood. Therefore, understanding the current urban fabric, the regenerative process starts by integrating the whole urban system into the mixed-use community that will effectively support people's social needs and encourages economic development in downtown Flushing.

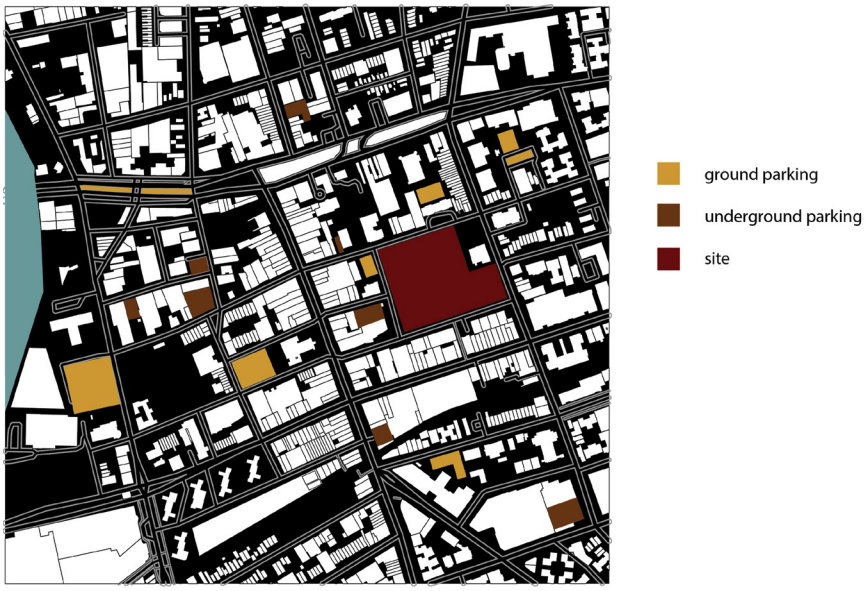

Figure 3.10 shows vicinity analysis

The massing design of this project as shown in Figure 3.11 lands at 41% residential in blue, 20% residential in red, 16% office in grey, 10% hospitality in orange, 7% recreational in light glue and 6% institutional in green. With addition parking and open plaza area, the Municipal Lot symbolizes a function-oriented design that meets people's needs while pushing forward the economic development for a regenerative and synergistic neighborhood.

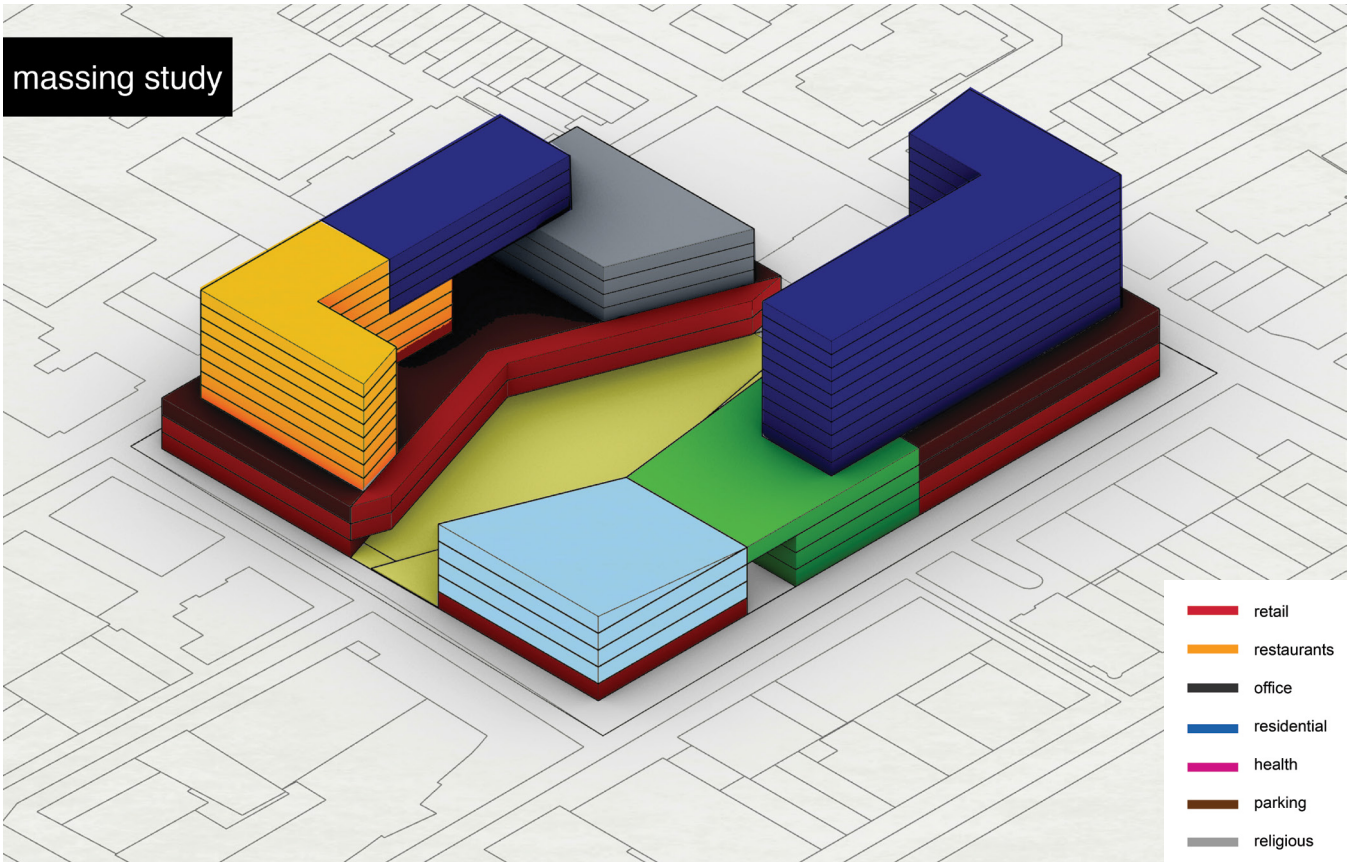

Figure 3.11 shows the proposal of massing study

Regenerative design towards ecological resilience is crucial for our future cities. Today, the world is facing increasing environmental crises. In the United States, the energy consumption of buildings takes up about 40% of the total carbon emissions[11]. The modern lifestyle based on the extensive usage of electricity and power supply on vehicles, lighting and space heating greatly increases carbon emissions. Therefore, the design of energy-efficient systems and the usage of locally attainable materials is key to reduce carbon emissions for future development.

11. Adrian Smith + Gordon Gill. Toward Zero Carbon: The Chicago Central Area De-Carbonization Plan Hardcover, 2011.print.

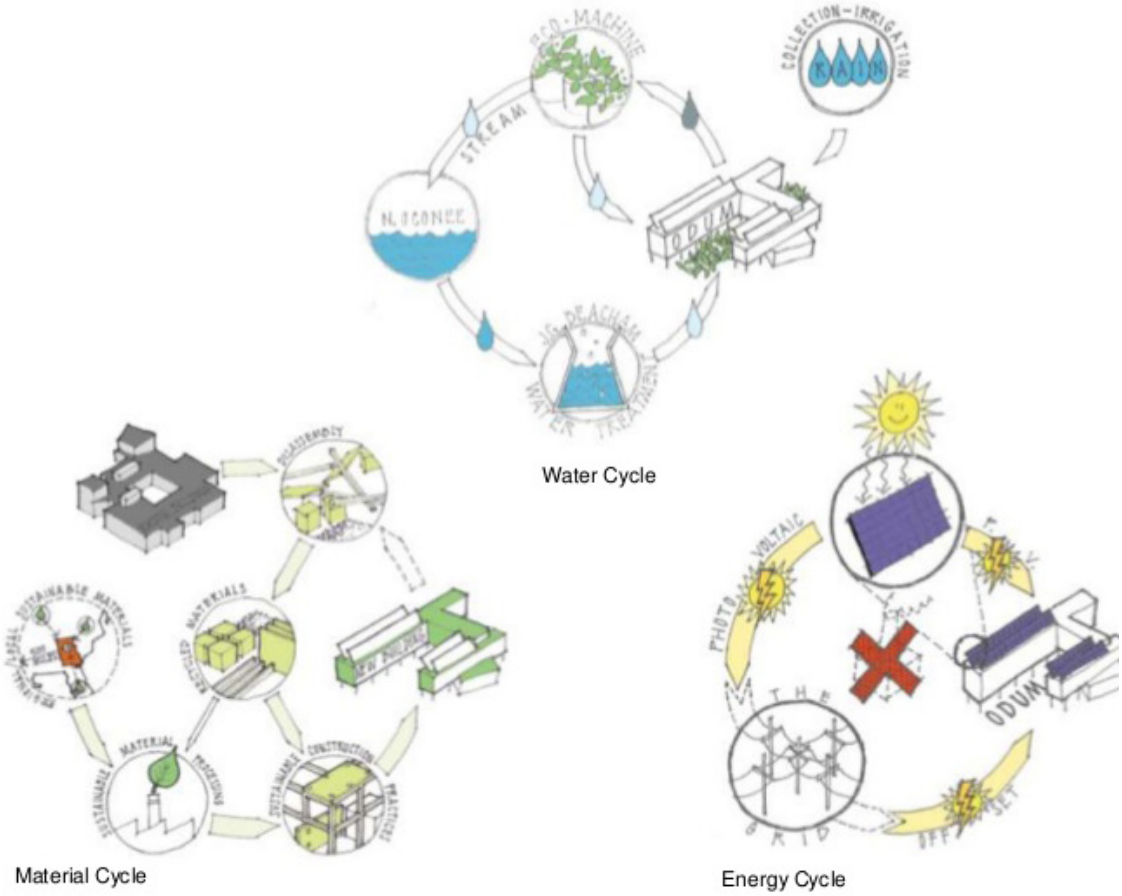

Figure 3.12 shows the ecological concerns towards water, material and energy cycle

We live on a planet where resources are limited. If we continue to consume and exhaust these resources, the outcome would be irretrievable. Therefore, regenerative design focusing on ecological resilience will not only help budget the limited resources but also encourage a greener lifestyle of consumption, which will eventually contribute to smarter future cities[12]. Additionally, according to the United Nations, by the year 2050 around 68% of the world's population will be urbanized[13]. When more areas become urbanized, would that accompany increasing environmental problems including pollution of soil, air, loss of natural spaces and overflowing waste?

Regenerative design becomes an ongoing process that restores and reactivate the city's source of energy and materials. The scope of this environmental concern is not only limited to the system design of each individual buildings, but also the entire urban system. How shall we create the most resilient system that realigns the human activities with our natural environment? Regenerative design in this context will explore the energy-conscious design methods that help create more dynamic and greener cities in the future.

In this chapter, we will look at two design projects and understand how they each contribute to a more ecological neighborhood and sustains our environment over time.

12. Palazzo, Danilo, and Frederick R Steiner. Urban Ecological Design: a Process for Regenerative Places. Washington, DC: Island Press, 2011. Web.

13. Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2006 Revision and World Urbanization Prospects: the 2007 Revision, http://esa.un.org/unup

a. Abu Dhabi Beach in Celebration of Natural Material

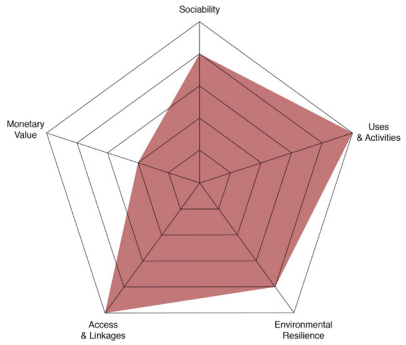

Figure 3.13 conceptual framework evaluation

Spring 2019
Prof. Jenny Sabin
ARCH Studio: Human-centered Adaptive Architecture in the UAE

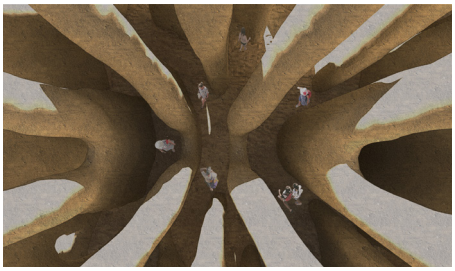

Figure 3.14 shows sand as the main construction material

Historically featured with beautiful coastal line and abundant resources for fishing, salting and pearling, the beach along UAE recently encountered potential environmental concerns including desalination, pollution, and waterfront thinning[14]. The design project intends to create a new nature along the beachside, taking use of onsite sand as material and with its maximized contact surface to hold and stabilize the sand from washing away, as is shown in Figure 3.14 and Figure 3.15. When the world is completing on the glass and steel high-rises, this installation on the beach intends to depart away from materials with high-embodied energy and using natural materials for construction. Additionally, sand with the material property to retain heat and moisture forms a great onsite cooling and shading structure, especially during the hot climate in Abu Dhabi.

Figure 3.15 shows the sand as the main construction material

14. Todorova, Vesela. "Desalination Threat to the Growing Gulf." The National, The National, 31 Aug. 2009, www.thenational.ae/uae/environment/desalination-threat-to-the-growing-gulf-1.553346.

a. Abu Dhabi Beach in Celebration of Natural Material

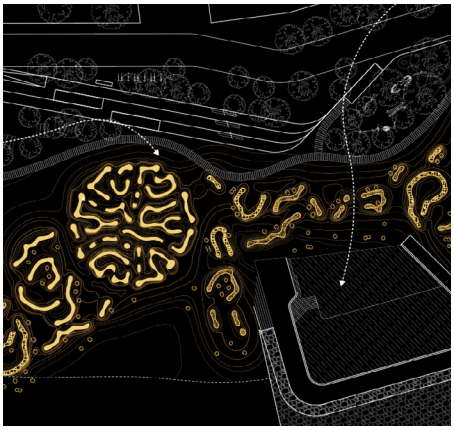

Figure 3.16 shows three scales of hut, bar counters and public seating in connection to site

The sand structure is featured with three scales of huts, bar counters and public seating, which help support diverse human activities along the beach. With the robotic fabrication as the main construction method, the automated fabrication process not only greatly saves the labor work but also at smaller scale realizes human-robotics interaction. The connection of this site to the surrounding urban environment invites people to enjoy this process and various activities.

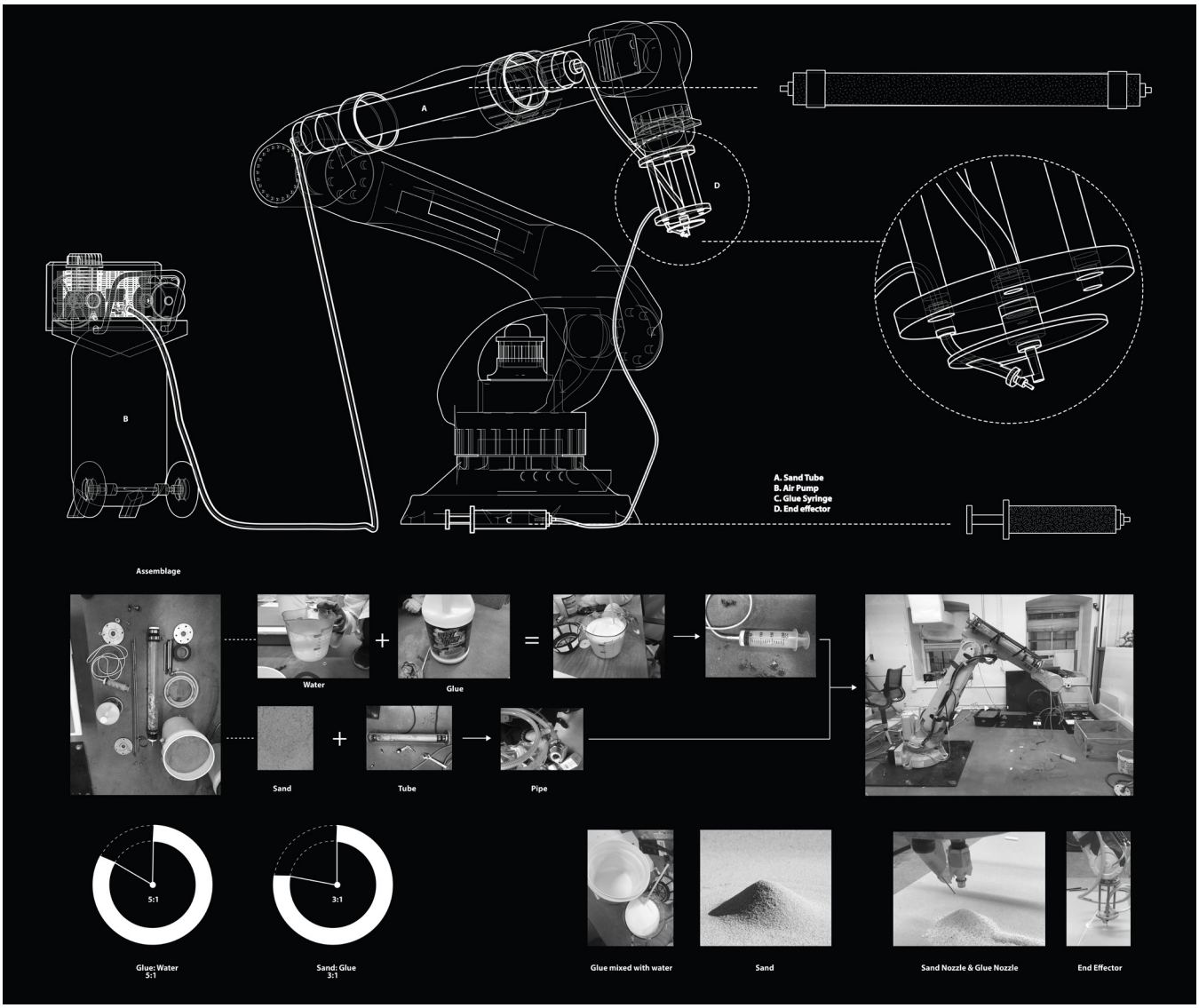

Figure 3.17 shows the robotic fabriction in details and the proportion of using sand as material

b. Roosevelt Island in Embracing Renewable Energy

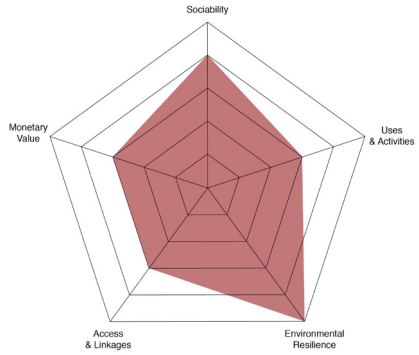

Figure 3.18 conceptual framework evaluation
Summer 2018
Prof. Tei Carpenter, Jesse LeCavalier
ARCH Studio: Architecture + Ecology

As an ecological infrastructure for future-oriented protein cultivation, this project located on Roosevelt Island is incorporating renewable energy into its building system. Comparing to the traditional protein cultivation of cattle and chicken, which will take three times the area of the island to produce the same amount of protein to serve the people, the future protein of crickets and microalgae will only take less than 100 square meters for the same amount of protein cultivation[15]. Additionally, the infrastructure of microalgae and crickets' cultivation will take use of solar and tidal energy as part of the cultivation process. The use of renewable energy will significantly reduce the energy demand for protein cultivation.

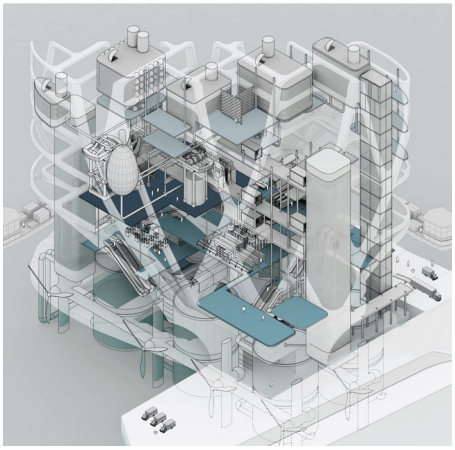

Figure 3.19 shows the small footprint of the ecological infrastructure using solar and tidal energy

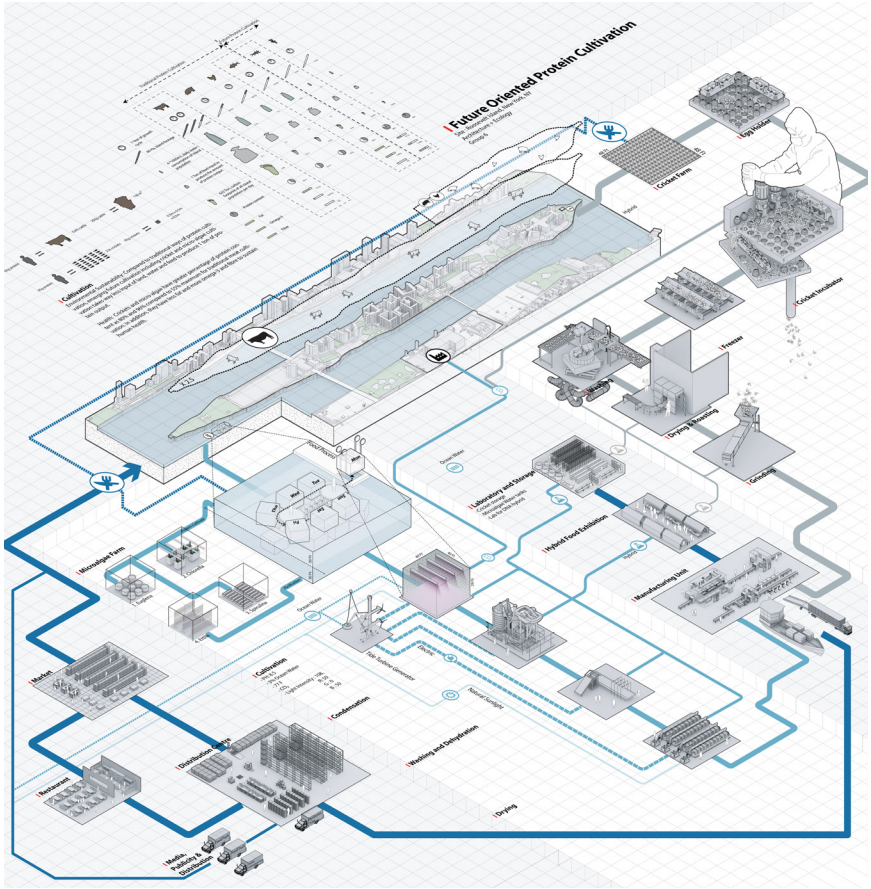

Figure 3.20 shows the information mapping analysis of future-oriented protein cultivation

15. Henchion, Maeve, et al. "Future Protein Supply and Demand: Strategies and Factors Influencing a Sustainable Equilibrium." Foods, vol. 6, no. 7, 2017, p. 53., doi:10.3390/foods6070053.

b. Roosevelt Island in Embracing Renewable Energy

Furthermore, the infrastructure is promoting a new lifestyle for people to engage with healthier and less energy-demanding protein for daily consumption, which will greatly contribute to the reduction of carbon footprint within the urban environment. The concept of taking use of renewable resources in the building system and the purpose to promote a much healthier lifestyle is an important part of the regenerative design for the city. Living on a planet with limited resources, part of the regenerative process is to create energy conscious design that will contribute to a more sustainable city.

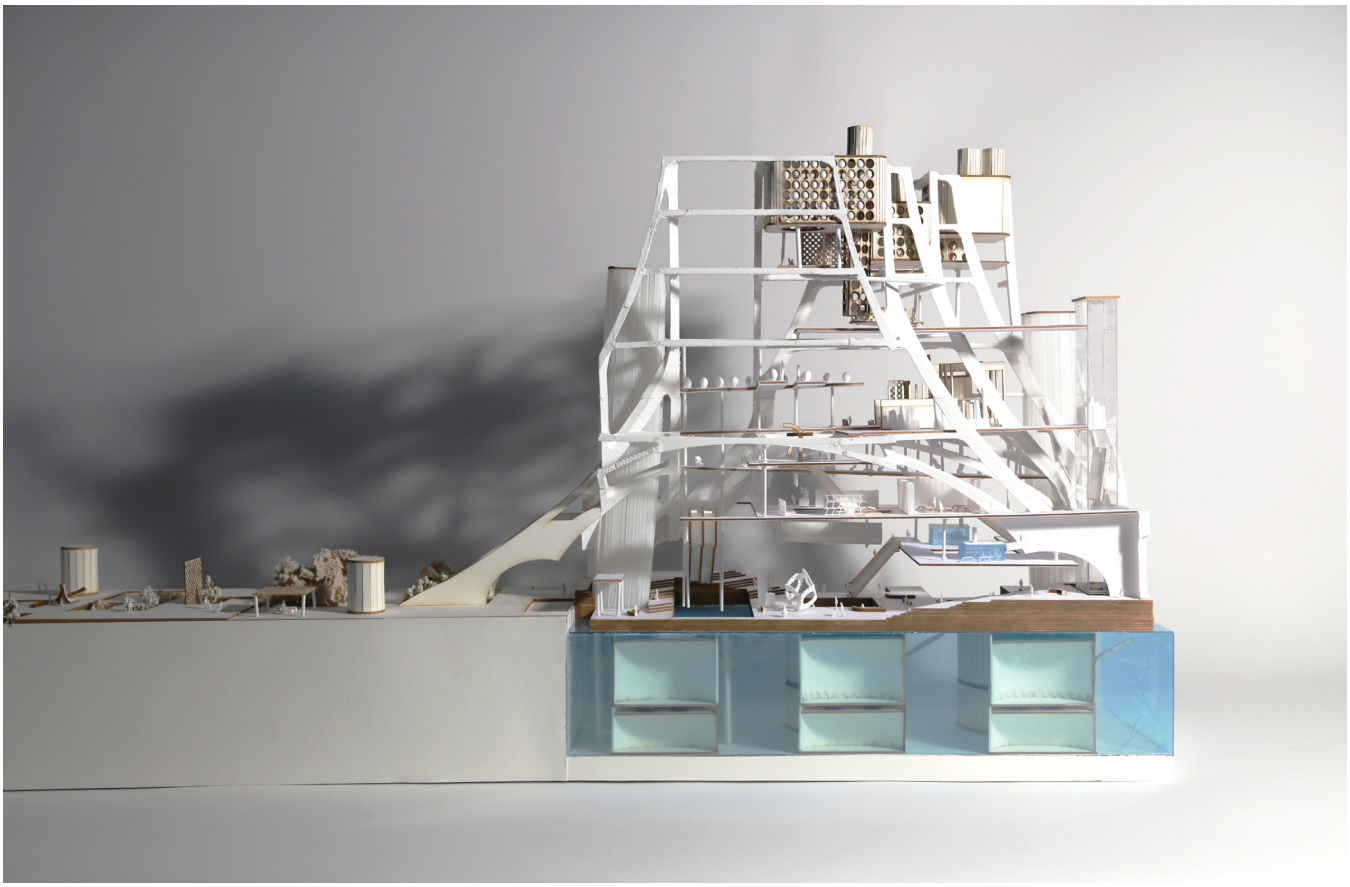

Figure 3.21 shows the physical model of the infrastructure system

With the increasing number of cities becoming urbanized and clustered by inhabitants, by the year 2000, more than 24 cities in the world have exceeded 10 million inhabitants[16]. Under this urban condition, our world is facing an increasing number of environmental problems and becomes less resilient to social fluctuations. In order to relieve the problems of resource consumption which may threaten the global environment and people's health, the regenerative design that connects to the urban fabric and respects the nature becomes as an essential method to restore and revitalize our energy and resources.

16. Yeang, Ken. The Green Skyscraper: The Basis for Designing Sustainable Intensive Buildings. Prestel, 2000.

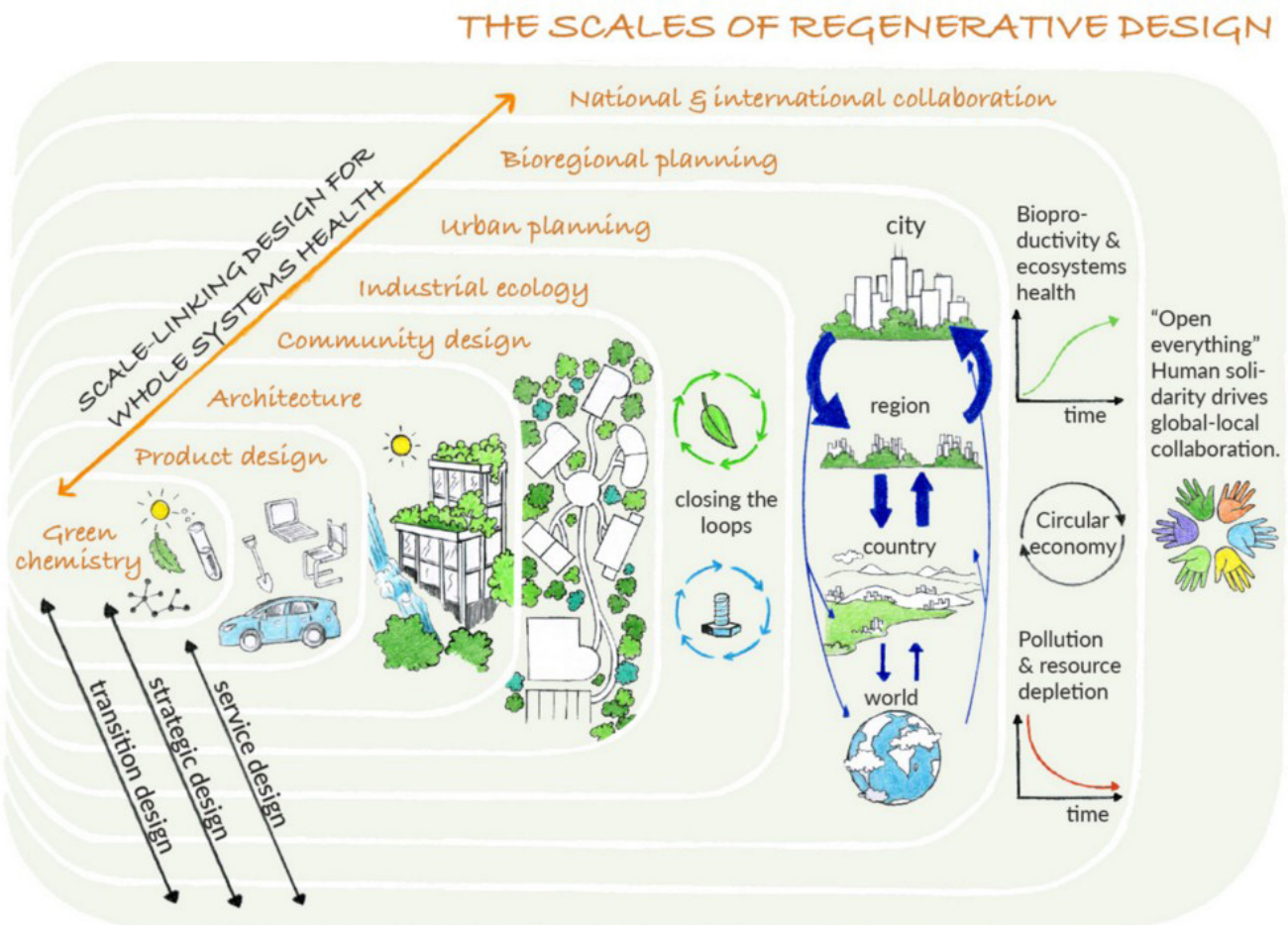

Figure 3.22 shows the regenerative design in multiple scales within our urban system

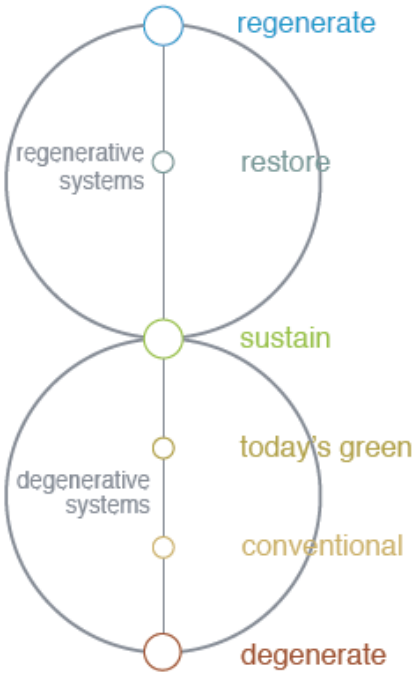

Figure 3.23 shows regenerative design to restore and sustain the resources within our cities

Regenerative design is crucial to be adapted into the building system for renewable resources and efficient envelopes. More importantly at a city level, it explores critically into the lifestyle, social structure, and zoning within the urban context. By creating architecture that encourages mixed-use activities and diverse social groups, space will become more dynamic when supporting the social life of people[17]. Imagine when more green space, street retails and entertainment venues are incorporated into the city fabric, people will conceive their living space as a safe, walkable, lively and restorative neighborhood. The value of regenerative design is not set up upon monotonous constructions, but the human-centered design that truly integrates every dimension of the civic realm into the building system and urban fabric respects our natural resources and celebrates the invaluable social capital of all.

In conclusion, regenerative design, both in architectural and urban scale, serves as an important strategy to create value and shape our future cities. It is a process not to exhaust but to regenerate our resources. More importantly, it helps create a level of social cohesion and environmental consciousness collectively among people to treasure our cities and vibrant urban life[18].

17. Lyle, John Tillman. Regenerative Design for Sustainable Development. New York: Wiley, 1994. Print.
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